BALLISTIC GELATIN MIXING PROCEDURES PRACTICED BY THE FBI

In December 1988, the FBI Academy Firearms Training Unit (FTU) designed and implemented the FBI Ammunition Tests. The test designs are based on research and consultation with experts in the fields of wound ballistics, forensic pathology, wound research and medical research. The tissue simulant utilized in FBI ballistic tests is **Vyse Ordinance Gelatin.**

The mixture is 10%, by weight. The mentioned research shows that properly calibrated 10% ordinance gelatin is a reliable tissue simulant. Calibration of ballistic gelatin is verified by firing a .177 steel BB at 590 feet per second (fps), plus or minus 15 fps, into the gelatin, resulting in 8.5 centimeters (cm), plus or minus 1 cm, penetration (2.95" – 3.74"). During FBI tests, any gelatin blocks, which fail the calibration test, are discarded. Calibration results are not published due to the Pass/Fail nature of the test.

Mixing Gelatin

The gelatin is mixed in the following manner (assuming a twenty-pound block is desired)

1) Weigh out two (2) lbs. of gelatin powder and place aside
2) Weigh out 18 lbs. of hot 60° C (140° F) water in a plastic bucket. (Note: The FBI utilizes a scale, which weighs to the nearest .01 lb)
3) Place 2.5 ml of Foam Eater in water
4) Place approximately .5 ml. of oil of cinnamon into water (prevents fungus growth)
5) While utilizing a battery-operated drill with a mixing paddle attached, mix the water to the point of forming a whirlpool, **without introducing air into the mixture**
6) While the water is being mixed, slowly add the gelatin powder
7) Pour the mixture into a clean mold pan
8) Allow to stand at room temperature for approximately 4 hours
9) Write date on small square of cardboard and place on top of mixture
10) Place pan with mixture into refrigerator set at 4° C (39.2° F)
11) Allow curing for 36 hours (note: larger blocks require longer cure time. (e.g. an 80lb block requires 96 hours to cure)

Blocks, over time, deteriorate and are temperature sensitive. Former FBI publications advocated utilizing blocks within 20 minutes of removal from the refrigerator, a general statement pertaining to ambient temperature indoors). Allowable time outside the refrigerator is, however, relative to the temperature of the test environment (e.g. a block removed from a refrigerator and maintained in a room at the same temperature as the refrigerator will retain its calibration significantly longer than one placed outside on a hot summer day).

Note: Some authorities believe mixing procedures may vary the consistency of gelatin. FBI studies indicate, however, that a block, which displays the required level of penetration, within the required velocity range, is a "valid" tissue simulant. The FBI Ballistic Research Facility conducts its tests in an environmentally controlled shooting laboratory. The blocks of gelatin are removed from the refrigerator and checked for calibration. Only valid blocks are used for test.

Blocks used in testing of conventional pistol ammunition are approximately 6.25" X 6.25" X 16". The initial block of gelatin used in a test is referred to as **"The Primary Block".** Each Primary Block is utilized for a maximum of five shots, one in each corner, approximately 1.75" from the nearest edge, and one in the center.

Tests conducted by the FBI indicate this placement of shots results in substantially the same penetration as single shots into virgin blocks of gelatin. Any shots, which cross the wound path of previous shots, are re-fired. Primary blocks are not utilized for more than five shots, to include any shots, which are re-fired.

Because some shots may penetrate more than one block of gelatin, one or more "stopper" blocks are placed behind the primary block. The stopper blocks may be utilized for more than one test, if the wound channels are not crossed. At the end of each test, the stopper block is placed back into the refrigerator while another stopper is utilized with an unused Primary block.

Stopper blocks may receive more than five penetrations; if no wound channels are crossed, (e.g. a stopper, which has five penetrations of 3" into one end, can be flipped over and used as a subsequent "stopper.")

The FBI does not reuse gelatin. Used blocks are discarded.

FBI PENETRATION TESTING

The purpose of the **FBI Penetration Test** is to determine the following information regarding a particular cartridge:

1) The penetration performance of the cartridge's projectile, throughout the series of eight tests (depth of penetration to nearest .25 inch, expansion of projectile, retained weight of the projectile).
2) The average velocity both from A test barrel and a service weapon.
3) The average accuracy both from A test barrel and a service weapon.
4) The test medium utilized is 10% ballistic gelatin, by weight.

Tests one through six are shot at a distance of 10 feet from the muzzle to the first barrier.
Seven and Eight are shot at a distance of 20 yards from the muzzle.

1) **Test One** - Bare Gelatin

2) **Test Two** - Heavy Clothing - The gelatin block is covered with four layers of clothing. One each of the following:
    - **A)** cotton t-shirt material (approx 48 threads per inch & 5.25 ounces per square yard)
    - **B)** Cotton dress shirt material (approx 85 threads per inch & 3.5 ounces per square yard)
    - **C)** A down comforter (500-550 fill power) in a cambric shell (approx 232 threads per inch)
    - **D)** Denim (approx 50 threads per inch & 14.4 ounce per square yard)

The shots are fired to not impact on a stitch line of the comforter. Tests 3-6 utilize light clothing (e.g. the cotton t-shirt and dress shirt materials above), in addition to the mentioned intermediate barrier.

3) **Test Three** - Steel - Two pieces of 20 gauge, hot-rolled steel with a galvanized finish are set three inches apart. The clothing covered gelatin block is placed 18 inches behind the rear most piece of steel. This test event simulates the weakest part of a car door.
4) **Test Four** - Wallboard - Two pieces of ½-inch standard gypsum board are set 3.5 inches apart. The gelatin block is placed 18 inches behind the rear most piece of gypsum. This test event simulates a typical interior building wall.
5) **Test Five** - Plywood - One piece of 3/4 inch "AA" fir plywood is set 18" in front of the gelatin block. This test event simulates the resistance of typical wooden doors or construction timbers.
6) **Test Six** - Automobile Glass - One piece (15" X 18") of A.S.I. 1/4 inch laminated automobile safety glass is set at an angle of 45° to the horizontal and 15° to the side, resulting in a compound angle. The gelatin block is placed 18 inches behind the glass. This test event simulates a shot taken at the driver of a car from the left front quarter of the vehicle.
7) **Test Seven** - Heavy Clothing at 20 yards. This test event repeats test event 2, but at 20 yards.
8) **Test Eight** - Automobile Glass at 20 yards. This test repeats test event 6, but at 20 yards and without the 15° horizontal offset. This simulates a shot at the driver of a car bearing down on the shooter. **Close Quarter Battle (CQB)** testing is designed to provide information regarding the performance of projectiles fired from commonly used carbines

The CQB testing consists of tests 1-7 and the following: **Bare Gelatin at 100 yards Exterior Wall at 10 feet** - This test assesses the effectiveness of rounds fired into lightly clothed gelatin through a common exterior wall (2" X 4" studs covered by 5/8" gypsum board and 3/4" plywood with 3.5" of fiberglass insulation and vinyl siding).

Body Armor - This test assesses the performance of the projectile when fired against a subject wearing Level III-A Body Armor. If the III-A panels stop the projectile, it is retested against Level II-A (both test results would be published). The penetration shots are conducted with a test barrel.

When practical / available, in order to allow for more consistent comparison of the AMMUNITION, the results received from a test barrel might be the same, or different than, those from a service weapon.

A service weapon is utilized during velocity and accuracy tests in order to show a perspective of the deviation, if any, from the test barrel. **It is important to note that a cartridge should not be chosen solely due to its accuracy from a service weapon, unless that accuracy is compared to other cartridges fired from the same EXACT service weapon.** Results may vary somewhat from firearm to firearm, including functional characteristics. One pistol may be substantially more accurate, or produce higher velocity than another of the same make and model produces. Each test report will clearly specify the weapon used for testing.

CRITERIA FOR WHICH THE FBI WILL CONDUCT PENETRATION TESTING FOR OUTSIDE AGENCIES

Ammunition must conform to the voluntary standards recommended by the Sporting Arms & Ammunition Manufacturers Institute (SAAMI).

1) Ammunition must be "Newly Manufactured" and consist of no previously used or loaded components
2) Ammunition must be currently utilized, or being strongly considered, as a duty round by the requesting agency
3) Ammunition must be currently available to the Law Enforcement market
4) Ammunition must be substantially different from other ammunition previously tested by the FBI. (Identical projectiles at the same velocity from different companies will generally not be tested)
5) Request must be made on Official Agency Letterhead Stationary, signed by a supervisory level or higher officer. Two hundred rounds of ammunition must accompany request from the same lot number. No ammunition will be returned.